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ABSTRACT

This paper discusses MacCrimmon's general theoretical framework for collective decisions, reveals the modeling for collective decisions, and presents selected descriptive research in the general area of collective decisionmaking. The intent is to stimulate research or provide insight that could have practical implications for management information system design. Although decision theory is individually oriented, as research becomes more applied, researchers will be led to the problem of collective decisionmaking. (Author/DW)

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SOME OBSERVATIONS ON THEORIES OF COLLECTIVE DECISIONS

by

Herbert Moskowitz

Paper No. 428 - October 1973

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OBSERVATIONS ON THEORIES OF COLLECTIVE DECISIONS

The purpose of this paper is to discuss several issues regarding the theory of collective decision making with the hope of stimulating research interest in this area of utmost importance. The significance of this area of study is manifested by the ubiquitous use of collective decision making instruments in contemporary organizations (e.g., committees, juries, boards, panels, etc.) and societies (voting constituencies, etc.), and growing interdependence of activities within and among organizations.

Unfortunately, there does not appear to exist a commonly accepted definition of the term collective decision, nor has a broad theory of collective decision making as yet evolved (Tuite, Chisholm, and Radnor, 1972). In this paper, a recent effort by MacCrimmon (1973) to develop a general theoretical framework for collective decisions is first discussed briefly. Following this, focus shifts to some selected descriptive research performed in the general area of collective decision making with the object of pointing to some opportunities for research that may either shed new light on old, but existing controversial, theoretical issues (e.g., the "choice shift" phenomenon in individual versus group studies using the Kogan and Wallach (K & W) Choice Dilemmas Questionnaire), or may provide behavioral insights that could have practical implications for organizational and Management Information System (MIS) design.

Toward a Definition and Theoretical Framework

MacCrimmon (1973) defines the term collective decision in the following way:

> A "collective" or "multiple person" decision situation arises when the activities of two or more individuals are interrelated.

Lieberman (1971) and Coleman (1971) define collective decision making in terms of the process by which individual preference patterns are combined into a social choice. White (1973) views collective decision making as either: (1) Group Decision Making, Single Decision - there may be several decision makers who contribute to the decision process by virtue of their own knowledge and values, through some mechanism, but in which there is one final decision (e.g., the committee decision type situation, in which, for example, it is trying to agree on some company policy); (2) Multi-Person Decision Making, Multiple Decisions - there exists a group of decision makers, each making a decision with or without communication (e.g., a team or game type situation).

Lieberman's and Coleman's perspective, while perhaps the most commonly accepted in the psychological and political sciences, is more restrictive than either White's or MacCrimmon's. MacCrimmon's view seems the most general. Although he focuses on the multiple person, multiple decision problem, he also treats social choice, group format, gaming, and other relevant issues impinging on the collective decision as key variables.

MacCrimmon's attempt to describe a general framwork for collective decision making apparently was stimulated by two factors (the first

being the predominant one): (1) A need for an analytical framework for analyzing actual intra- and inter-organizational decision situations;[1] and (2) a need to develop a framework which may lead to an expanded theory of collective decision making. (An enormous task, indeed as shown in Figure 1 by the disciplines impinging on such a theory).

Insert Figure 1 about here

In brief, MacCrimmon attempted to do three things: (1) develop a framework for modeling collective decisions, based on various structural and behavioral elements; (2) present a detailed examination of his models with particular emphasis on the types of inferences that can be made with them; and (3) develop a mathematical structure to formally characterize his models.

Model basis. The structural and behavioral elements of MacCrimmon's models are: (1) structural - individuals participating in collective decisions perform functions, either singly or in combination, as (a) information units, (b) decision units, and (c) action or implementation units; (2) behavioral - individuals (or task units) behave in either a comprehensively rational manner or in a constrained or boundedly rational manner. Given these two fundamental dimensions MacCrimmon develops, by combinatorial manipulation of the dimensional elements, a set of models characterizing decision situations ranging from a single person to a complex collective of many individuals performing varied functions across organizations (Figure 2).

Insert Figure 2 about here

Model details. In his models MacCrimmon described: (1) the defining characteristics of each model (to serve as guidelines or heuristics for determining the appropriate model(s) to use in analyzing a given type of collective decision situation); (2) the key variables associated with each model; (3) some model-related descriptive and normative literature from various disciplines and topical areas; and (4) some real decision situations and then proceeded through the relevant models in an attempt to explicate and/or predict the behavior that occurred or would occur.

Model formalization. The system of notation prescribed by MacCrimmon essentially follows that of Marschak and Radner (1972, Chapter 8), which views behavior as communication or information exchanged from one entity or functional unit to another.

Significance. MacCrimmon's contribution, in sum, rests principally in his taxonomy, and its value for analyzing real decision situations. His separation of the decision unit from the action unit is useful in this regard. The list of key variables for each of his models suggests some areas for behavioral research that would contribute new knowledge on how collective decisions are made.

Research on Collective Decision Making

Discussion will be confined to two basic areas: (1) the individual versus group response issue (i.e., concerning judgments, decisions,

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utility functions); and (2) team theory. Research in the first area includes the "choice shift" issue (see, e.g., Kogan and Wallach, 1967; Castore, Peterson and Goodrich, 1973; Goodman, 1972; and Davis, 1972 and references cited therein), the "conservatism" issue in probabilistic inference (see, e.g., Goodman, 1972; Moskowitz, 1971, Gustafson, Shukla, Delbecq, and Walster, 1973) and action selection of gambles (e.g., Goodman, 1972). Individual versus group differences in these large bodies of literature have been explained principally in terms of changes in individual member preferences (e.g., in the 'choice shift' literature, shifts have been attributed to diffusion of responsibility, familiarity, cultural values, etc). Little consideration has been given to any effects that might be due to the social choice function used for amalgamating individual preferences into a collective choice (Davis, 1972 and references cited therein). The social choice function can, however, importantly affect the collective choice. To show this, a primitive example (viz, a choice between two gambles) is used to demonstrate theoretically the effect of several voting rules on group behavior. The results of this simple exercise provide insights regarding several additional key variables affecting group choice processes.

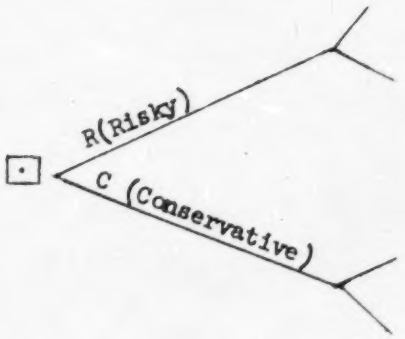
Related to the above issue is the question of how to amalgamate individual member utility functions into a social utility function. This will also be discussed briefly.

The second major area, team theory, also seems to offer a number of interesting opportunities for research in collective decision making. This stems partly from the flexibility of the team theory model for

investigating a number of research areas (MacCrimmon, 1970), and the potential implications of the research findings for organizational and MIS design.

Effects of Voting Rule

Consider a group composed of n members, who have individual preferences for either one of two gambles (say, a risky versus a conservative one), and who must choose as a collective, one of these two gambles.



What are the effects of the following voting rules on the ultimate group choice: (1) Dictatorial (D), (2) Unanimity (U), and (3) simple Majority Rule (MR)? More precisely, given that individual members have certain preferences for either R or C, what is the probability that the group will choose R or C (or, not choose at all)?[2] Two cases will be examined. In Case 1, the probability of selecting a given gamble is assumed to be identical for all individuals.[3] It is also assumed that any individual in a given group is equally likely to be the dictator, and that all individuals must choose one of the two gambles (these assumptions also apply to Case 2). The binomial formula (or multinomial formula if more than two alternatives were involved) can then be used to determine

the probability of the group selecting the risky or conservative choice, or making no choice at all (i.e., $P_G(R)$, $P_G(C)$, or $P_G(NC)$ respectively). These computations were performed for the various voting rules as a function of group size (n), using the binomial formula, e.g.,

$$p_G(R) = b(x; n, \theta) = \binom{n}{x} \theta^x (1 - \theta)^{n-x} \qquad (1)$$

where e.g., x ≡ number of individuals choosing the risky alternative R, n ≡ group size, and θ ≡ probability of an individual choosing the risky alternative. The results of these computations are shown in Figures 3 and 4 for θ = 0.5 and 0.2 respectively. To illustrate the computations, using a unanimity rule and letting n = 3

$$p_G(R) = b(3; 3, 0.5) = \binom{3}{3} 0.5^3 \, 0.5^0 = .125$$

For the simple majority rule

$$p_G(R) = \sum_2^3 b(x; 3, 0.5) = \sum_{x=2}^3 \binom{3}{x} 0.5^x \, (0.5)^{3-x} = 0.5$$

Insert Figures 3 and 4 about here

Figures 3 and 4 show that: (1) the voting rules yield significantly different results, (2) the nature and magnitude of these differences are a function of group size n, (3) assuming that the amount of social interaction (discussion) is directly proportional to the probability of no choice, $p_G(NC)$, then the rules result in significant differences in the degree of social interaction. For example, the highest degree

of social interaction occurs with the unanimity rule, while no social interaction occurs under a dictatorship. Note that while social interaction is monotonically increasing in $\underline{n}$ for the unanimity rule, it is monotonically decreasing in $\underline{n}$ for the majority rule when $\underline{n}$ is even (when $\underline{n}$ is odd, no social interaction takes place for majority rule, since $p_G(NC) = 0$).

Now consider Case 2. Here the individual member preference patterns are assumed to be known (i.e., it is no longer assumed that the probability of selecting a given gamble is identical for all individuals). The impact of the voting rules on the matrix of choice probabilities are shown in Figure 5 for n = 3.

Insert Figure 5 about here

To summarize, the results of these simple exercises suggest that the following variables can significantly affect group choice (although not always): (1) number of available alternative choices, (2) group size,[4] (3) probability of an individual selecting a particular alternative, (4) voting rule, and (5) distribution of individual member preference patterns. Researchers should thus pay considerably more attention to such variables in any future individual versus group studies.

Deriving Social Utility Functions

How should individual preference functions be "pooled" or amalgamated into a "composite" or social utility function? In addressing this

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question it is assumed that multi-attribute utility functions of the individual group members have been derived using linear multiple regression estimation techniques. A number of regression studies have been concerned with obtaining a composite mathematical function characterizing the group process. Typically, the approach has been to develop the composite model from the totality of data available from all individuals comprising the group in question (see, e.g., Goldberg, 1970 and references cited therein; Wiggins, 1973 and references cited therein; Ebert, 1972; Huber, Sahney, and Ford, 1969; and Ford, 1973). Technically, the use of such a procedure is correct only under a very restricted set of assumptions, i.e., when inter-individual importance weights attached to the attributes (β_is) and the constant (α_i) are equal. Should this set of assumptions be violated, other estimation procedures are necessary. These other procedures, also make precise assumptions regarding inter-individual equivalence and/or non-equivalence of the α_is and β_is. Figure 6 depicts several pooling procedures (and their associated assumptions regarding the α_i and β_is among individuals). Further discussion of these techniques and the general topic area is found in McCann, Miller, and Moskowitz (1973). Until recently, there has been relatively little research on this general issue. Econometricians are now increasingly devoting their theoretical attention to this problem.

Insert Figure 6 about here

Team Theory

Team theory extends individual decision theory to the multi-person situation, where all individuals are assumed to have common interests (viz, utility functions) and beliefs (viz, subjective probability functions). Although there has been little behavioral research on the theory of teams, it would seem to offer a number of research opportunities. A recent study by MacCrimmon (1970), for example, demonstrated the potentially high degree of research flexibility obtained with team theory models. The implications of such investigations would not only be of some theoretical interest, but would provide useful insights regarding organizational and MIS design. For example, consider the practical question of centralization versus decentralization of information and authority in a financial institution composed of a headquarters and several branches. Prospective borrowers apply for loans at the branches. The branches either decide on the loan request or, if the loan is above a certain size, pass it up to headquarters where a decision is made for the branch to implement (Figure 7). What size loan applications should be processed at headquarters versus the branches? This decision should be based on: (1) the difference between processing costs at headquarters and the branches, (2) the differences in the probabilities of Type I (rejecting a good loan) and Type II (accepting a bad loan) errors made at headquarters and branches, (3) the apriori probability of an applicant repaying the loan, and (4) the profit rate (as a proportion of loan size).

Insert Figure 7 about here

To acquire some behavioral insight into this problem, a laboratory experiment was performed using advanced graduate students in a masters program in industrial management (Moskowitz and Murnigham, 1973). One research issue in this study concerned the propensity of individuals to overcentralize or overdecentralize the information and authority structure (i.e., letting the branches make decisions regarding loans on loan sizes higher or lower respectively than that specified by the normative team decision theoretic model). The experimental results showed that subjects (acting as bank vice presidents) tended to over-decentralize small loan decisions and overcentralize large loan decisions (Figure 8). The functional relationship of this behavior resembled a damped sine wave, and was explained in terms of the Friedman - Savage (1948) doubly inflected utility function.

Insert Figure 8 about here

Summary and Conclusions

The dominant focus of research in decision making by Bayesians has been directed at the individual. It appears that this emphasis will continue at least in the immediate future (see, e,g., Table 1 which roughly summarizes the contributed papers of this conference by subject matter).

Insert Table 1 about here

Why is this so? First, decision theory is individually oriented. Second, multi-person decision theory has not been fully developed, unless we adopt a team theory orientation. And even here, it is only recent that a text on team theory has been published (Marschak and Radner, 1972). Third, how individuals judge and decide is only beginning to be understood. Little is still known about individual value systems and ways in which to best measure them. However, as research in decision making becomes more applied, the collective decision problem inevitably cannot be avoided. The behavioral decision theorist will no longer be able to rely solely on his discipline and training when this point is reached.

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Footnotes

[1]Allison's (1971) analysis of the Cuban missile crises had a major influence on MacCrimmon;and his paper, in part, is an extension of Allison's work.

[2]Although it is assumed that each individual member must choose either R or C only, it is conceivable that the group may not be able to make a choice, based on the primary voting scheme. In a realistic situation, however, an agreed upon secondary voting process would then have to be used.

[3]This could be interpreted to say, assuming individuals choose rationally in accordance with the postulates of decision theory, that all members have identical utility functions (team theory assumption).

[4]"Group size has generally been ignored or regarded as only moderately interesting for research. A major difficulty has been that the meaning of group size has not been anchored in theory as an interpretable parameter with exact consequences." (c.f., Davis, 1972).

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Table 1

Contributed Research Paper Topics

Topic	Frequency
Traditional (Lab) Inference & Decision	12
Utility Theory (Multiattribute Utility, Single attribute Utility)	6
Dynamic Decision Making	1
Applications (individual level)	5
Group (Collective) Inference and Decision Making	1
	25

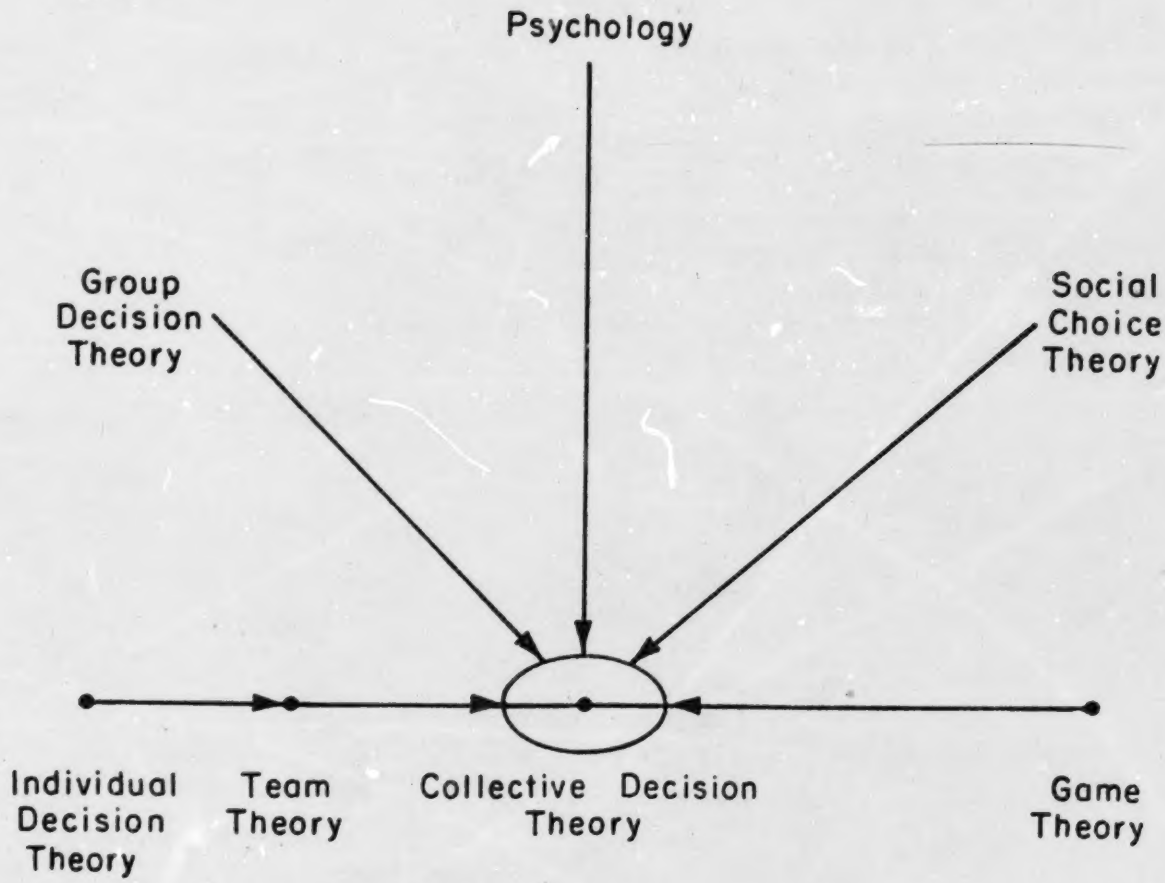

Fig. 1. Disciplines impinging on development of a collective decision theory

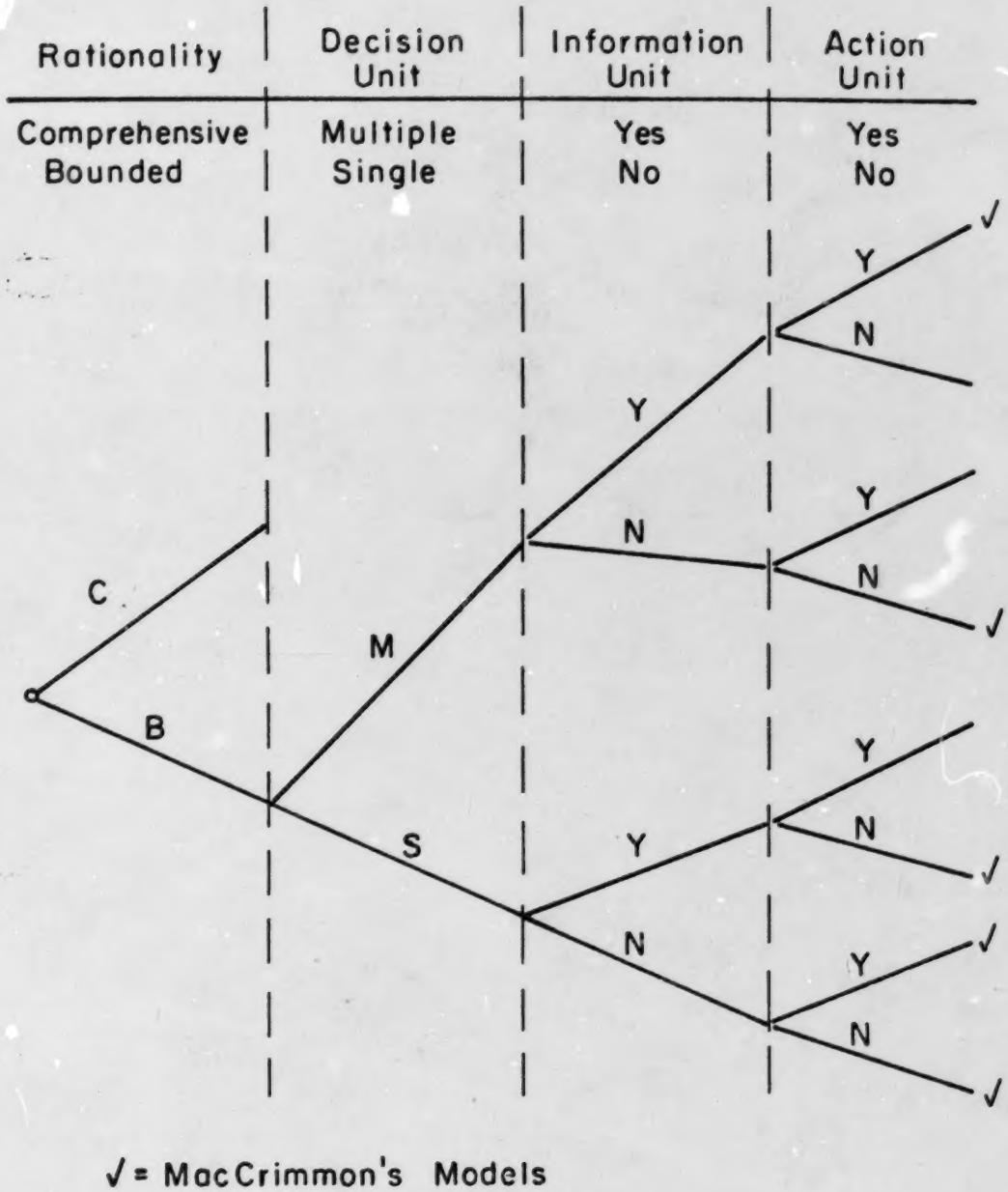

Fig. 2. **Models** of collective decisions

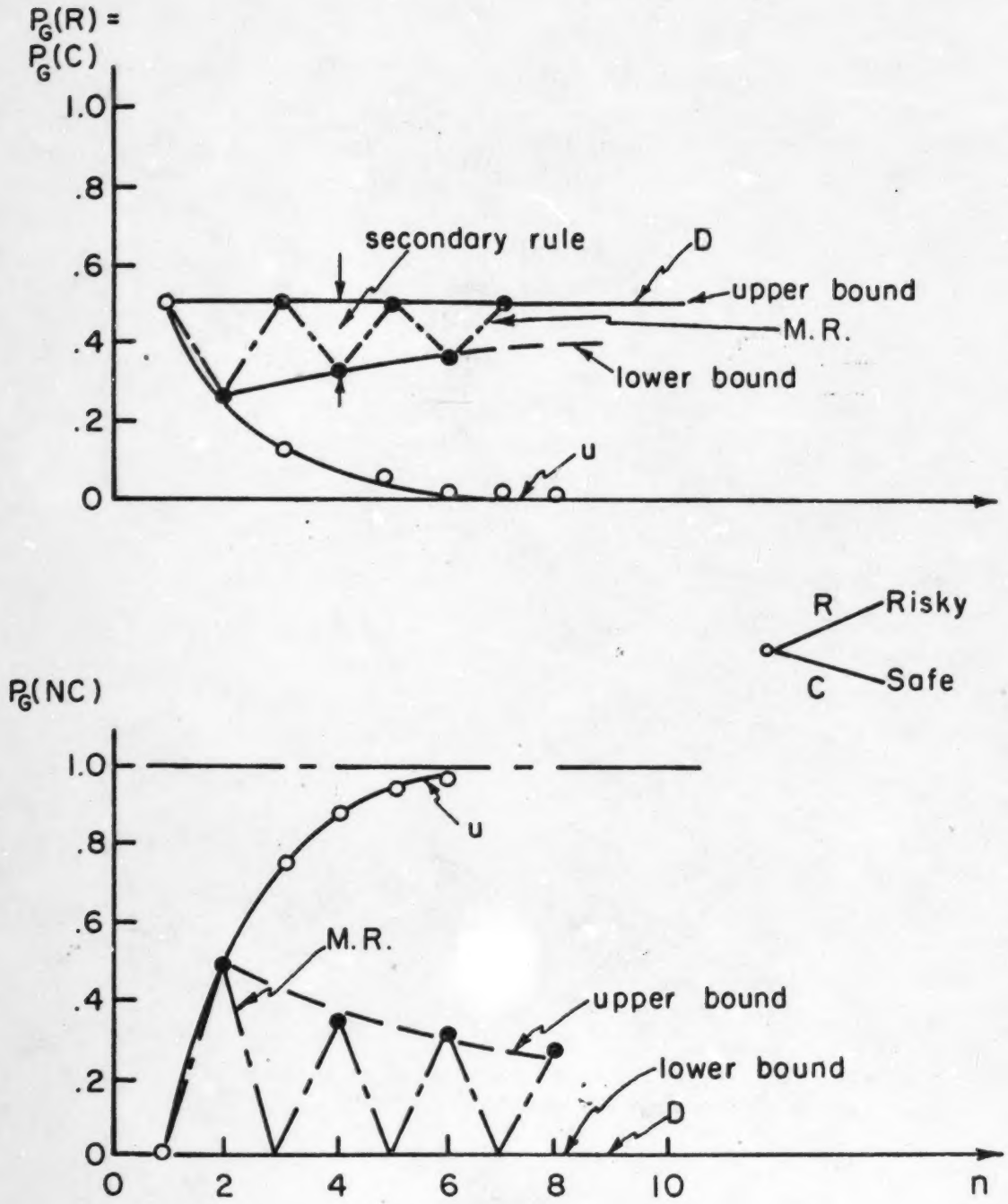

Fig. 3. Effect of voting rule on group choice: Case 1 ($\theta = 0.5$)

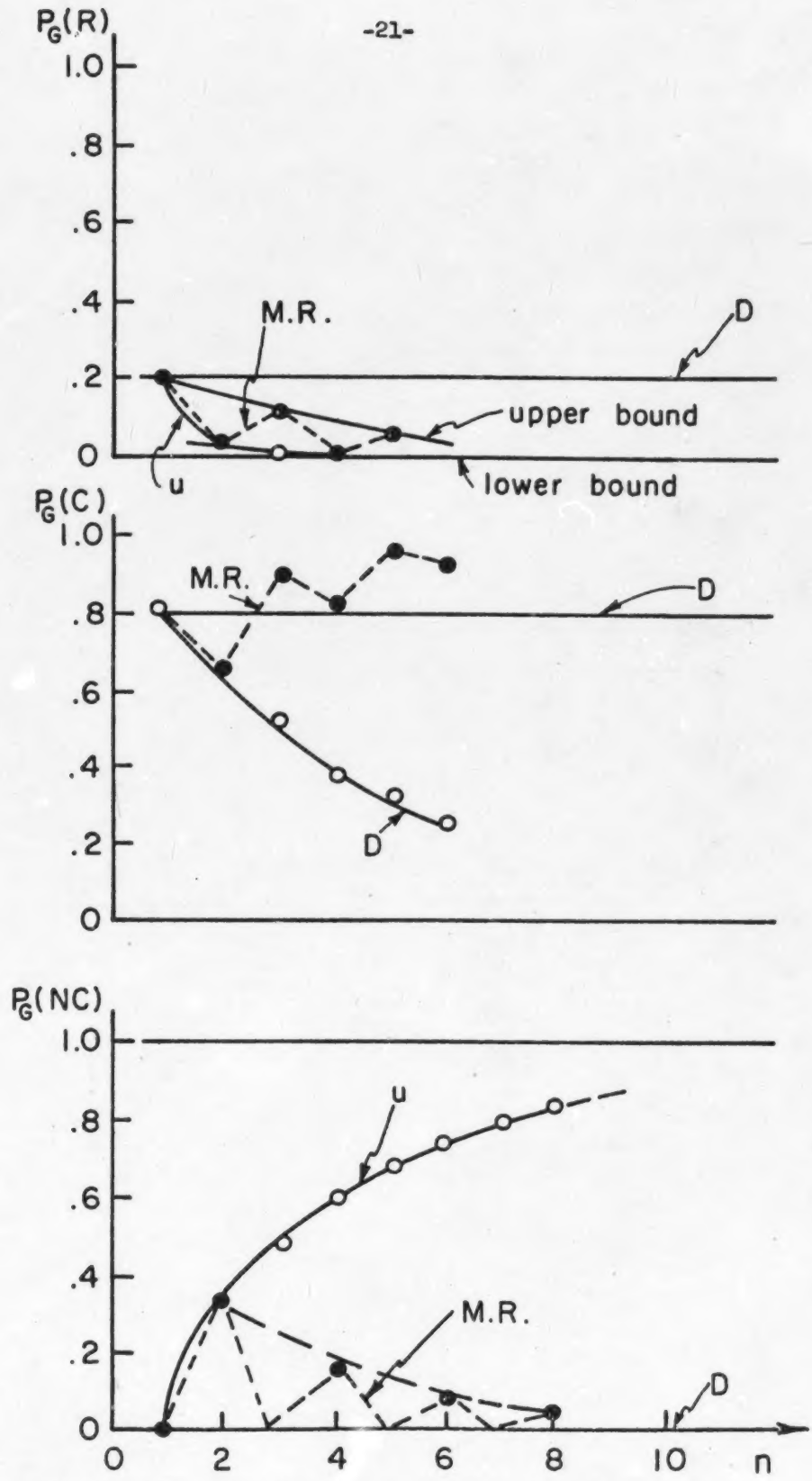

Fig. 4. Effect of voting rule on group choice: Case 1 ($\theta = 0.2$)

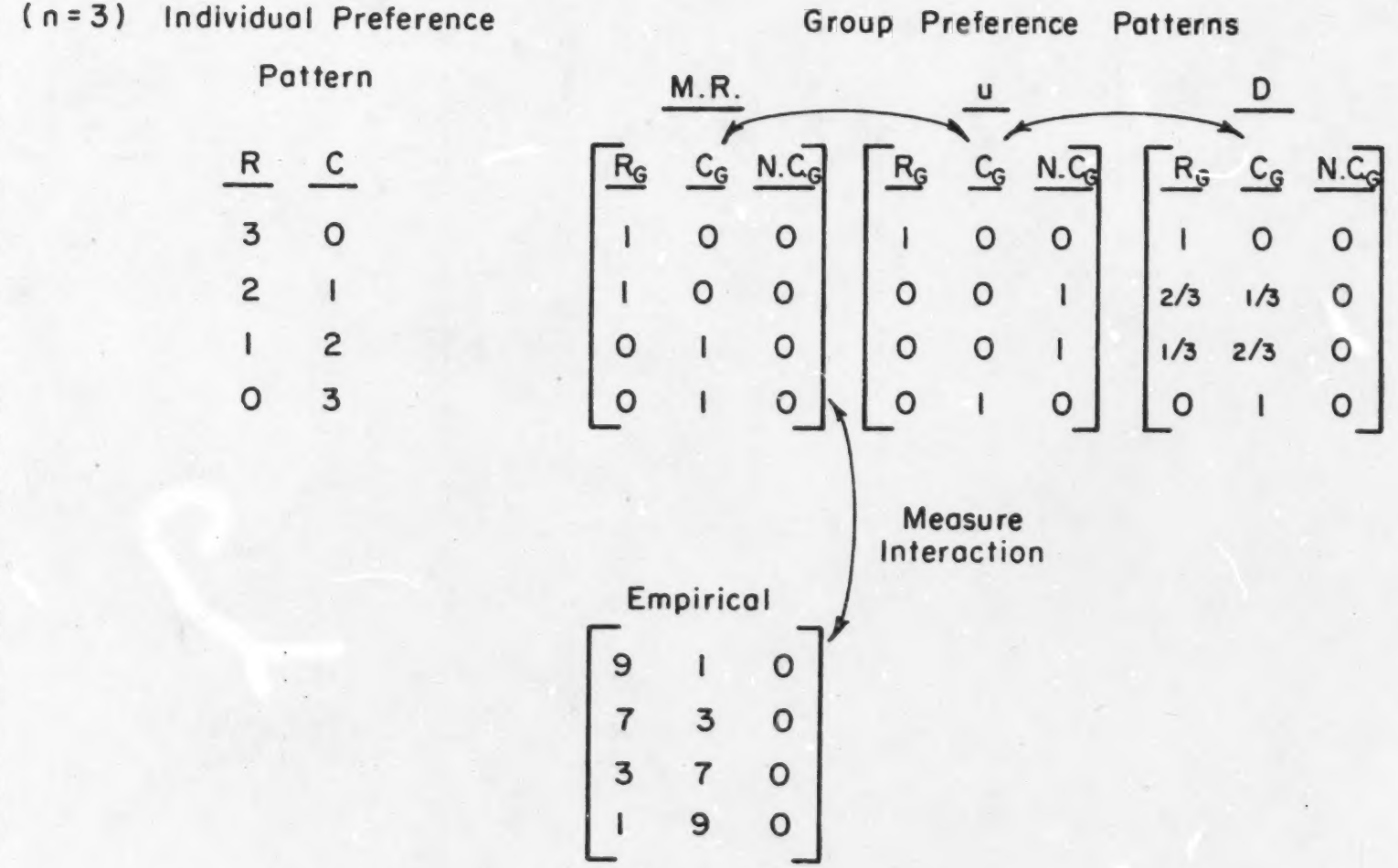

Fig. 5. Matrix of group choice probabilities conditioned on individual member preference patterns and voting rules: Case 2

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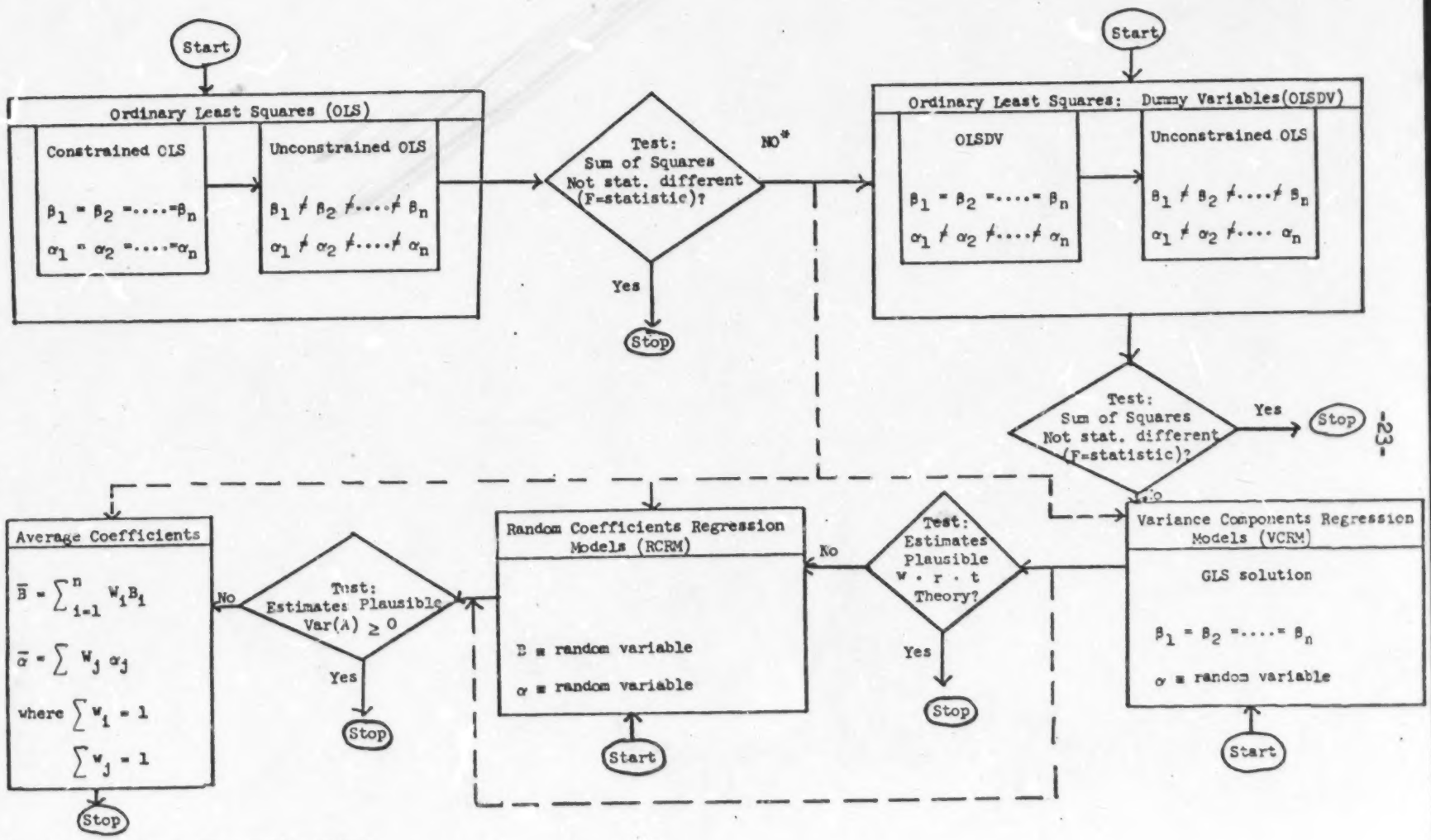

*No = reject method; yes = accept method

Fig. 6. Assumptions, estimation procedures, and tests for obtaining social utility functions based on regression.

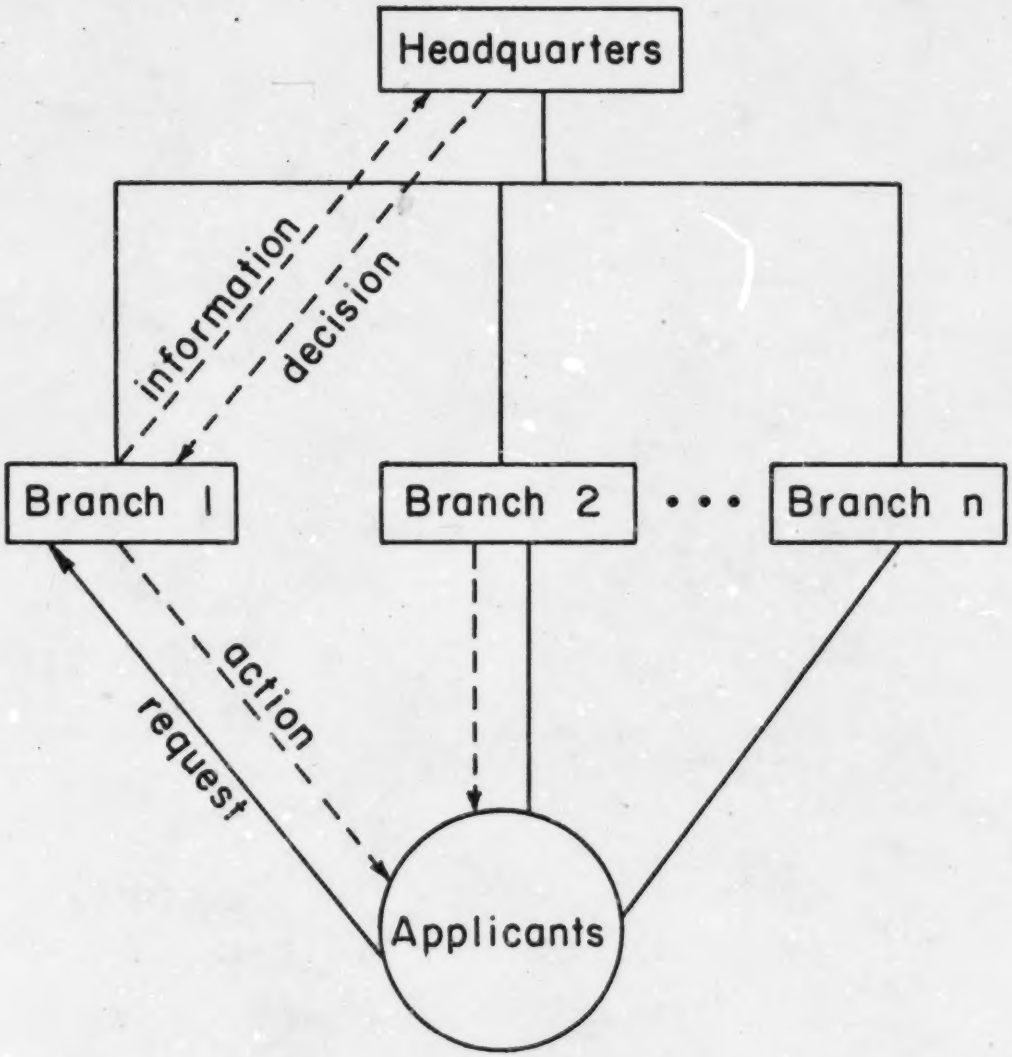

Fig. 7. Centralization vs decentralization: a team theory problem.

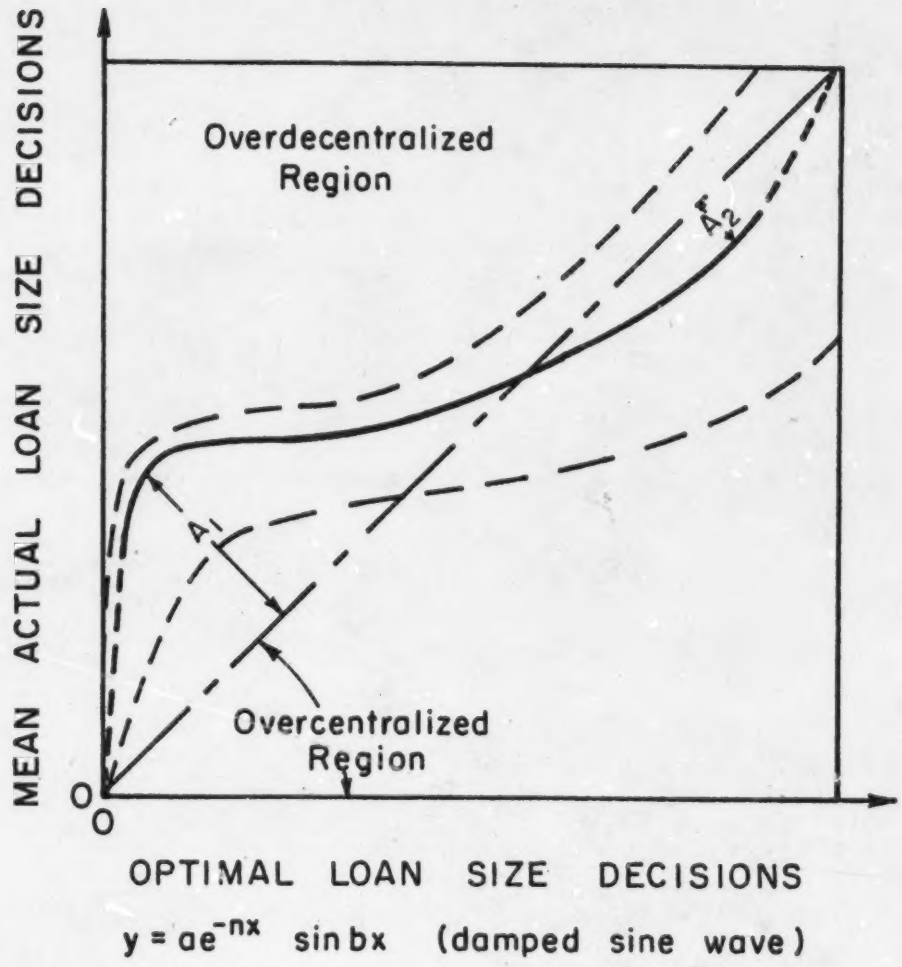

Fig. 8. Propensity of individuals to overdecentralize and overcentralize as a function of loan size.

Figure Captions

Fig. 1. Disciplines impinging on development of a collective decision theory.

Fig. 2. Models of collective decisions

Fig. 3. Effect of voting rule on group choice: Case 1 ($\theta = 0.5$)

Fig. 4. Effect of voting rule on group choice: Case 1 ($\theta = 0.2$)

Fig. 5. Matrix of group choice probabilities conditioned on individual member preference patterns and voting rules: Case 2

Fig. 6. Assumptions, estimation procedures, and tests for obtaining social utility functions based on regression.

Fig. 7. Centralization vs decentralization: a team theory problem.

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